

REMARKS

By the present amendment and response, independent claims 1, 11, and 20 and dependent claims 3-4, 6, 8-9, 13-14, 16, and 18-19 have been amended to overcome the Examiner's objections and claims 7 and 17 have been canceled. Thus, claims 1-6, 8-16, and 18-20 remain in the present application. Reconsideration and allowance of pending claims 1-6, 8-16, and 18-20 in view of the following remarks are requested.

The Examiner has objected to the drawings. In response, Applicant has amended Figure 3 by removing reference numeral "10" and its associated lead line. Applicant has enclosed herein one (1) replacement sheet including Figures 1, 2, and 3.

The Examiner has rejected claims 3, 4, 6, 8, 9, 13, 14, 16, 18, and 19 under 35 USC §112, second paragraph. Applicant has amended claims 3, 4, 6, 8, 9, 13, 14, 16, 18, and 19 and submits that the requirements of 35 USC §112, second paragraph, have been met.

The Examiner has rejected claims 1-20 under 35 USC §102(e) as being anticipated by U.S. patent number 6,515,368 B1 to Lopatin, et al. ("Lopatin"). For the reasons discussed below, Applicant respectfully submits that the present invention, as defined by amended independent claims 1, 11, and 20, is patentably distinguishable over Lopatin.

The present invention, as defined by amended independent claims 1 and 11, recites, among other things, "forming a Cu surface on a semiconductor substrate" and "electroplating the Cu surface in the chemical solution, thereby forming a Cu-Zn alloy

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thin film on the Cu surface, wherein the Cu-Zn alloy thin film completely covers the Cu surface." As disclosed in the present application, the present invention provides a particular electroplating method which controls the parameters of Zn concentration, pH, temperature, and time in order to form a uniform reduced-oxygen copper-zinc alloy (Cu-Zn) thin film on a Cu surface in a semiconductor device, where the uniform reduced-oxygen copper-zinc alloy thin film completely covers the Cu surface. As a result, the present invention advantageously achieves reduced electromigration in the semiconductor device by decreasing the drift velocity therein, which decrease the Cu migration rate in addition to decreasing the void formation rate.

In contrast, Lopatin does not teach, disclose, or suggest "forming a Cu surface on a semiconductor substrate" and "electroplating the Cu surface in the chemical solution, thereby forming a Cu-Zn alloy thin film on the Cu surface, wherein the Cu-Zn alloy thin film completely covers the Cu surface." Lopatin is directed to reducing electromigration in copper interconnect lines by restricting Cu-diffusion pathways along sidewalls and top and surfaces of a Cu-filled via. Lopatin specifically discloses Cu interconnect line 3 formed on semiconductor substrate 4 and acting as the bottom portion of via 6. See, for example, column 5, lines 39-41 and Figure 1 of Lopatin. Via 6 includes optional barrier layer 10 formed on sidewalls and bottom of via 6, optional underlayer 19 formed on optional barrier layer 10, Cu surface 20 formed on optional underlayer 19, and first interim Cu-Zn alloy thin film 30 formed on Cu surface 20. See, for example, column 5, lines 44-51, and Figure 1 of Lopatin.

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Thus, in Lopatin, Cu interconnect line 3 is formed on semiconductor substrate 4 and a bottom portion of via 6 is formed on Cu interconnect line 3. However, Lopatin fails to teach, disclose, or suggest forming a Cu surface on a semiconductor substrate and electroplating the Cu surface in a chemical solution, thereby forming a Cu-Zn alloy thin film on the Cu surface, wherein the Cu-Zn alloy thin film completely covers the Cu surface, as specified in amended independent claims 1 and 11.

For the foregoing reasons, Applicant respectfully submits that the present invention, as defined by amended independent claims 1 and 11, is not suggested, disclosed, or taught by Lopatin. Thus, amended independent claims 1 and 11 are patentably distinguishable over Lopatin and, as such, claims 3-6 and 8-10 depending from amended independent claim 1 and claims 12-16 and 18-20 depending from amended independent claim 11 are, *a fortiori*, also patentably distinguishable over Lopatin for at least the reasons presented above and also for additional limitations contained in each dependent claim.

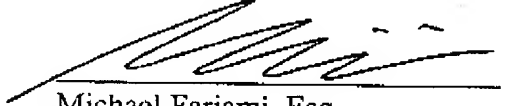
The present invention, as defined by amended independent claim 20, recites, among other things, "a reduced-oxygen Cu-Zn alloy thin film formed, by electroplating, and disposed on the at least one Cu surface, wherein the reduced-oxygen Cu-Zn alloy thin film completely covers the at least one Cu surface." The present invention, as defined by amended independent claim 20, provides similar advantages as the present invention as defined by amended independent claims 1 and 11 as discussed above. For similar reasons as discussed above, the present invention, as defined by amended independent claim 20,

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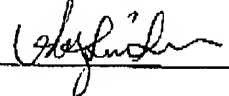
is not suggested, disclosed, or taught by Lopatin. Thus, amended independent claim 20 is patentably distinguishable over Lopatin.

Based on the foregoing reasons, the present invention, as defined by amended independent claims 1, 11, and 20 and claims depending therefrom, is patentably distinguishable over the art cited by the Examiner. Thus, claims 1-6, 8-16, and 18-20 pending in the present application are patentably distinguishable over the art cited by the Examiner. As such, and for all the foregoing reasons, an early allowance of claims 1-6, 8-16, and 18-20 pending in the present application are respectfully requested.

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Respectfully Submitted,
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REPLACEMENT SHEET

Replacement Sheet

1/4

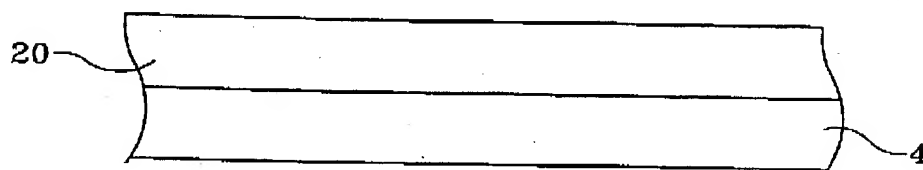


Figure 1

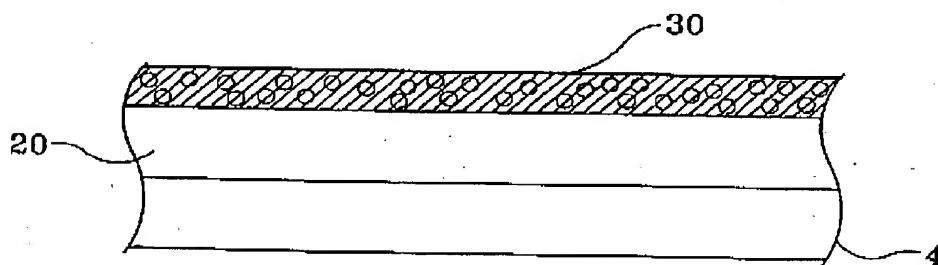


Figure 2

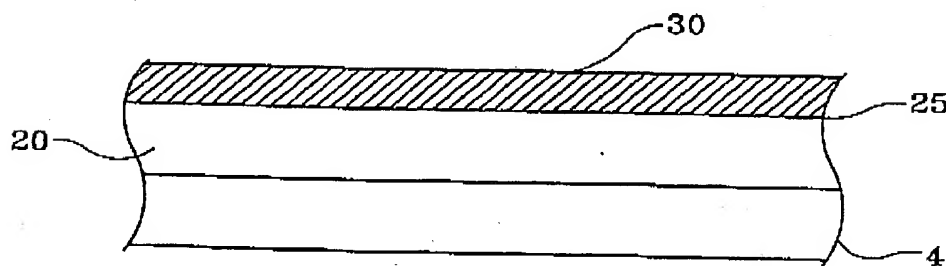


Figure 3